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(54) **Sets of golf clubs**

(57) In a matched set of golf clubs the mass of each club head is so distributed as to establish a generally oval shaped "sweet area" on the striking face wherein impact with the ball at a pre-determined head velocity results in a carry of at least 90% of that obtained when impact at the same head velocity is made with the "sweet spot", namely the point on the striking face which on impact with the ball will propel it for the maximum distance for any given head velocity, the major axis of the "sweet area" being horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°. Empirical methods of ascertaining and adjusting the "sweet area" in prototype clubs are described.

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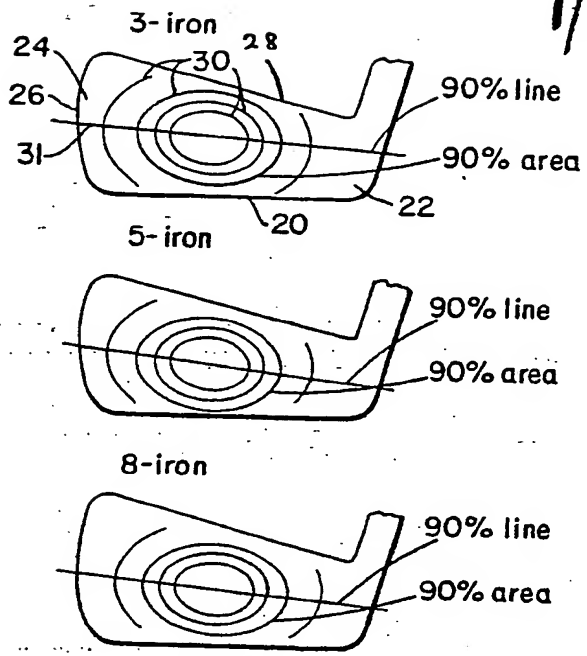


FIG. 1

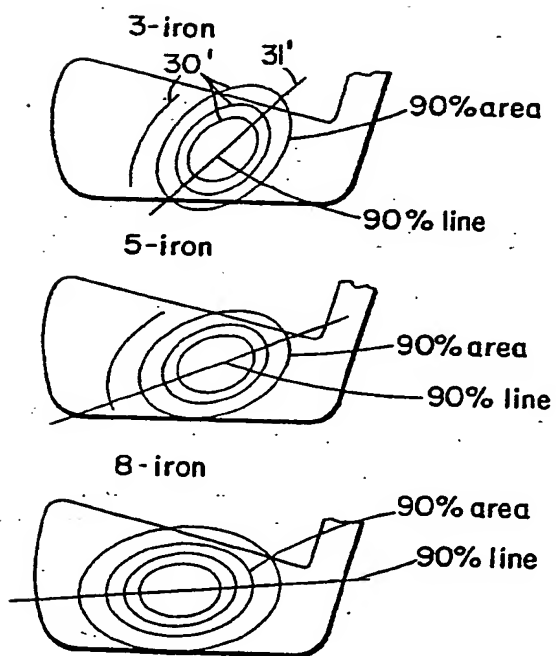


FIG. 2
(PRIOR ART)

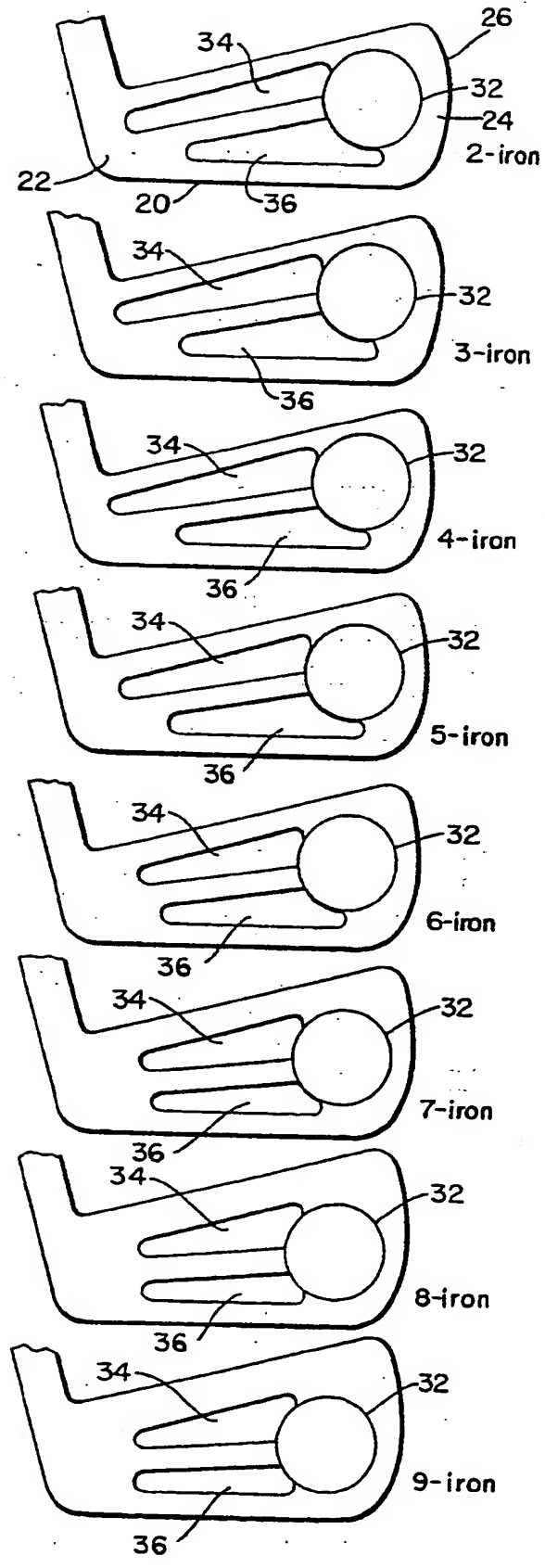


FIG. 3

SPECIFICATION

Sets of golf clubs

5 This invention relates to sets of golf clubs, more particularly to matched sets of iron clubs.

It has long been recognized that every golf club regardless of design has a "sweet spot", that is, an unmarked point on the striking face of the club which, upon impact with the ball, will propel the ball the maximum distance for any given club head velocity.

It is also generally recognised that the average golfer seldom strikes the ball with the sweet spot. Failure to strike the ball with the sweet spot may result in loss of distance as much as 50% particularly in the low loft clubs and the loss of the distance is usually coupled with the loss of directional control.

Many hits, even by skilled golfers, are made slightly to the heel or toe side of the sweet spot, although at the proper vertical distance above the sole of the club.

To overcome or lessen these effects, many attempts have been made to expand the sweet spot to an area of close to maximum distance for any club head velocity usually by the addition of weights or the provision of specially located cavities or ridges on the rear face of the club head. While these efforts to expand the area of the sweet spot have met with partial success, nevertheless, little if any attention has been paid to the matter of the proper location and orientation of a sweet area. As used herein, the term "sweet area" means an area on the striking face of a golf club wherein impact with the ball at a predetermined head velocity results in a carry of at least 90% of that obtained when impact at the same predetermined head velocity, is made with the sweet spot.

A study of the performance of commercially available golf irons has shown that although some clubs have a sweet spot located at or close to the geometric centre of the striking face, the surrounding area immediately adjacent the sweet spot varies greatly in effectiveness in propelling the ball. In some irons, a hit about 1 cm to either side of the sweet spot might result in a shot of only 60-70% of the distance obtained when a hit using the same head velocity is made at the sweet spot. In other irons a hit up to about 2.5 cm on the heel or toe side of the sweet spot may result in a shot of about 90% of maximum distance, i.e. when the hit is made at the sweet spot at the same head velocity.

When testing commercially available so called "matched sets" of irons great disparity is found in the size and orientation of the sweet area, although in a few isolated cases one or two clubs of a set of eight irons do possess the characteristics necessary to produce what the inventor has discovered to be optimum location and orientation of the sweet area. However, so far as is known, this result has been achieved fortuitously without rigorous analysis and without knowledge or appreciation of the performance characteristics of the club. Analysis of other clubs in the same set has revealed wide and undesirable variations in the size, location and orientation

of the sweet area.

The prior art, for example U.S. Pat. No. 1,642,462, reveals recognition of the desirability of providing a set of irons having a sweet spot in the same location in all clubs. However, neither that patent nor any other known prior art reveals how this objective is to be achieved, nor does it deal with the problem of the proper location or orientation of the sweet area. Other U.S. patents referring to the location of the sweet spot in at least one club are Nos. 1,917,774; 2,062,673; 2,846,228; 3,059,926; and 3,751,035. A related development is disclosed in U.S. patent Nos. 3,855,820 and 3,995,865.

None of those prior proposals, so far as is known, has achieved reliably identifiable and reproducible location and orientation of the sweet area, and none has resulted in a set of clubs all having matching correlated optimum sweet area characteristics.

It is an object of the present invention to provide a set of golf clubs having sweet areas of matched location and orientation.

According to the invention a matched set of golf clubs has heads of differing lofts, the head of each club having a substantially flat front striking face, a rear face, a sole, a heel and a toe, and the mass of each head is so distributed as to establish a generally oval shaped sweet area on the striking face with the major axis of the sweet area horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°.

The desired orientation of the sweet area may be achieved by the provision of at least one weight and at least one cavity in the rear face of each club head in the set. The size and disposition of the cavity and the weight may be determined empirically with the use of a ball hitting apparatus well known in the art.

The invention will now be described in more detail and by way of example with reference to the accompanying drawings, in which:—

Figure 1 illustrates the heads of three typical clubs of a set embodying the present invention showing the disposition of the sweet area in each of the clubs.

Figure 2 illustrates, for comparison, the disposition of the sweet area in the heads of three conventional clubs of corresponding loft; and

Figure 3 illustrates the rear faces of the heads of a complete matched set of irons embodying the present invention.

Apart from the club heads, golf clubs of a set embodying the present invention may be of essentially conventional construction incorporating shafts and grips of conventional construction and of varying lengths in accordance with conventional practice. Accordingly, for present purposes, only the club heads are shown and described.

Usually irons are sold in sets comprising clubs numbered 2-9. In general, No. 1 irons are used only by professionals, and pitching wedges and sand wedges are often sold separately. Accordingly, while the present invention is applicable to all golf clubs, it will be described herein as applied to the standard set of irons comprising the No. 2 to No. 9 irons.

As is apparent from a comparison of Figures 1 and 2, the heads of clubs embodying the present invention may be generally similar in outline configura-

tion to those of clubs of the prior art. In each case the club heads have a substantially flat sole 20 extending from a heel area 22 to a toe area 24 bound d by a generally vertical end surface 26 and an inclined upper edge 28. The lie or loft of the club heads may also follow conventional practice.

On the face of each club is shown a series of "equal distance" lines, such lines being indicated at 30 in Figure 1 and at 30' in Figure 2. Each of the equal distance lines is a plot of points of impact between the club and the ball which cause the ball to travel an equal distance. The equal distance lines are determined empirically by striking the ball at a large number of different points on the striking face of the club at a fixed and controlled head velocity. The distance travelled by each ball for each hit is measured and plotted. All plotted points of about the same distance are connected to form the ovals or elliptical curves 30 and 30'. A suitable machine for swinging golf clubs under predetermined conditions is described in the book "Golf Club Design, Fitting, Alteration and Repair" by Ralph Maltby published by Faultless Sports Division of Globetrotter Communications Inc. 160 Essex Street, Newark, Ohio 43055, U.S.A., on pages 295-297.

In each case the innermost line encloses the exact sweet spot. When the ball is struck on this spot, it will travel the maximum distance for any given club head speed. The outermost line defining a complete oval in each case plots impact points which will propel the ball 90% of this maximum distance. The area enclosed by the outermost line is termed the "sweet area".

The intermediate lines plot impact points which will propel the ball equal distances which are more than 90% of the maximum distance. Similar lines (not shown) may be plotted to show impact points resulting in less than 90% of maximum distance.

It will be noted that in the club heads of Figure 1 the equal distance lines are generally oval in shape and, of particular importance, display the same pattern and orientation for all three clubs. Also of particular importance is the orientation of the major axis 31 of the equal distance ovals. This axis, which may be termed the "90% line", joins the two impact points most remote from the exact sweet spot with which a ball may be struck with 90% efficiency. It will be noted that, in each case, this axis or 90% line is slightly upwardly inclined from the heel towards the toe of the club heads and that this disposition applies to each of the three club heads illustrated. The remaining clubs of the set will display the same pattern.

Actual testing has established that the advantages of the present invention may be achieved when the 90% line is horizontal or is inclined upwardly from the heel towards the toe at an angle of not more than 7°.

In marked contrast are the locations and orientations of the sweet area and the 90% line on the typical conventional clubs shown in Figure 2, the contrast being particularly evident in the case of the No. 3 iron which is representative of the low loft irons. It will be seen that the sweet area is of limited horizontal extent and that the 90% line is angled sharply

downwardly towards the toe. Accordingly, both the heel and toe of the club may be regarded as weak areas and a ball struck in either of these areas will travel unpredictably and for a distance which may only be about 60% of the maximum possible. Similar, though less notable, deficiencies are present in the No. 5 and No. 8 irons of conventional design.

Also, in the club heads of conventional design, the sweet areas vary considerably in pattern, distribution and orientation which makes the clubs of the set more difficult to use with predictably good results. From the empirical results obtained it appears that the location and orientation of the sweet area has not hitherto been considered in the design of clubs.

The disposition and orientation of the sweet area in the club heads of the present invention significantly improves the performance of the individual clubs, particularly the low numbered clubs such as the Nos. 2, 3 and 4 irons which are notoriously the most difficult to use. Actual experience has demonstrated, for example, that a shot hit from the upper toe portion or lower heel portion of these irons will travel much further and straighter than a similar shot made with a conventional club. As in all of the clubs of a set the size and orientation of the sweet area is substantially the same, the clubs are much easier to use with consistently predictable good results.

Referring now to Figure 3, which illustrates the rear faces of a matched set of irons embodying the invention, the desired weight distribution to provide the sweet area and orientation shown in Figure 1 is effected by the provision of a weight 32 suitably secured in a socket adjacent the toe of each club and a pair of cavities 34 and 36 which extend generally from near the heel of the club to the weight. Preferably, the weights 32 are tungsten or a similar material having a density appreciably greater than the density of steel from which the club heads are fabricated. While the weights 32 may be identical for all clubs in the set there is considerable variation in the configuration of the cavities 34 and 36. In practice, the configuration depth and location of these cavities may be determined in part empirically and, after tests, adjustments may be made as required to produce the desired sweet spot patterns and disposition of the 90% line.

In a particularly preferred embodiment of the invention the weights 32 are of conventional size and disposition. In designing the clubs to obtain the desired characteristics the cavities 34, 36 are adjusted by either adding or taking away metal at appropriate places until the previously described testing method results in a sweet area with its major axis horizontal or upwardly inclined from the heel towards the toe of the club at an angle of not more than 7°. For example, if testing of a club head reveals a sweet area disposition such as that shown in Figure 2 for the No. 8 iron, weight would be added to the upper cavity 34 or removed from the lower cavity 36, in order to raise the toe end of the 90% line (major axis of the sweet area). Weight is added to or removed from the cavities 34 and 36 depending on whether it is desired to raise or lower the overall weight of the club head. This process of hitting, measuring, plotting and adjusting the cavities is repeated until the

90% line is horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°.

While the invention is specifically described above in its application to the irons of a set, the principles thereof are applicable to and extend to the woods of the same set.

When a prototype set of irons according to the invention has been made by the foregoing trial and error (empirical) method, manufacturing apparatus can be adjusted and modified as necessary to reproduce the prototype clubs on a mass production basis.

The invention also embraces a method of making a prototype of a golf club suitable for inclusion in a set as aforesaid and having a head with a substantially flat striking face, a rear face, a sole, a heel, a toe, at least one weight and at least one cavity in the rear face, and a generally oval shaped sweet area (as hereinbefore defined) on the striking face with the major axis of the sweet area horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°, which method comprises the steps of:

- (a) repeatedly hitting a golf ball at a predetermined head velocity at a large plurality of points on the striking face;
- (b) measuring the distance travelled by the golf ball for each hit;
- (c) plotting the said points on the striking face as a function of distance;
- (d) connecting points of the same distance to form areas defined by oval lines;
- (e) locating the oval line enclosing points of at least 90% efficiency;
- (f) adjusting the cavity and weight in the rear face; and
- (g) repeating steps (a) to (f) until the major axis of the sweet area is horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°.

CLAIMS

1. A matched set of golf clubs having heads of differing lofts, the head of each club having a substantially flat front striking face, a rear face, a sole, a heel and a toe, and the mass of each head being so distributed as to establish a generally oval shaped sweet area (as hereinbefore defined) on the striking face with the major axis of the sweet area horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°.

2. A matched set of golf irons having heads of progressively different lofts, the head of each iron having a substantially flat front striking face and a sole, a heel and a toe, at least one weight and at least one cavity in the rear face of the head so arranged as to distribute the mass of each head to establish a generally oval shaped sweet area (as hereinbefore defined) on the striking face with the major axis of the sweet area horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°.

3. A set of golf irons as claimed in Claim 2 wherein the weight is positioned adjacent the toe of each head and each head has a pair of cavities in the rear face thereof extending from near the heel to the

weight.

4. A set of golf clubs including a plurality of irons each having a shaft and a head, each head having a different loft and a substantially flat front striking face, a rear face, a sole, a heel and a toe, and means in each head for providing a sweet area (as hereinbefore defined) generally oval in shape with the major axis of the oval horizontally inclined at an angle of not more than 7° upwardly from the heel towards the toe.

5. A set of golf clubs as claimed in Claim 4 wherein the said means comprise at least one weight and at least one cavity in the rear face of each of the heads.

6. A matched set of golf clubs substantially as described with reference to Figure 1 or Figure 3 of the accompanying drawings.

7. A method of making a prototype of a golf club suitable for inclusion in a set as claimed in any of the preceding Claims and having a head with a substantially flat front striking face, a rear face, a sole, a heel, a toe, at least one weight and at least one cavity in the rear face, and a generally oval shaped sweet area (as hereinbefore defined) on the striking face with the major axis of the sweet area horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°, the method comprising the steps of:

- (a) repeatedly hitting a golf ball at a predetermined head velocity at a large plurality of points on the striking face;
- (b) measuring the distance travelled by the golf ball for each hit;
- (c) plotting the said points on the striking face as a function of distance;
- (d) connecting points of the same distance to form areas defined by oval lines;
- (e) locating the oval line enclosing points of at least 90% efficiency;
- (f) adjusting the cavity and weight in the rear face; and
- (g) repeating steps (a) to (f) until the major axis of the sweet area is horizontal or upwardly inclined from the heel towards the toe at an angle of not more than 7°.

8. A set of golf clubs each of which is reproduced from a prototype made by a method as claimed in Claim 7.

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